A Preliminary Study on Colour Recogniser for Visually Disabled People

M.A.Wahid, M.Y.Ahmad, M.Z.Md.Zain, S.M.Saad, M.Hussein and Z.Ahmad
Faculty of Mechanical Engineering, Universiti Teknologi Malaysia, 81310 Skudai, Johor Bahru, Malaysia
zarhamdy@utm.my

***Abstract*—Nowadays, visually disabled people face difficulties to match the colour of everyday life. This comprises activity to find the colour of cloth, the colour of food and surrounding items near them. Before this, there are many methods developed to solve this problem like braille sticker with colour code embedded, human assisting and a device that can produce audio output from colour sensor data called colour recogniser. This paper presented a preliminary study on colour recogniser for visually impaired people. The colour recogniser consists of three components; microcontroller, a colour sensor and a pair of speaker. The colour sensor will read the colour of desired surface or object and send reading values to the microcontroller. The microcontroller will process the information and displayed the colour audio output through the speaker based on the recognised colour. The device is powered by dry cell batteries and also lightweight. It is designed to be user-friendly, practical and also easy to carry everywhere. To ensure the device is working correctly in determining the type of colour detected, an experiment to validate the device was performed with 12 standard colours. The result shows that validation of the colour recogniser has proved the ability of the colour recogniser. This device will be useful for visually disabled people and can help them to solve their difficulties to match the colour for everyday life.**

***Index Terms*—RGB; Colour Light to Frequency Converter; Speech Recognition.**

I. INTRODUCTION

Currently, about 285 million people are facing with vision loss problem globally where 39 million from them are considered complete blindness while the remainder which is 264 million are having limited vision or known as partial blindness [1]. About 90% of them are living in developing country. Blindness is defined as a lack of vision. It also can be referred to a loss of vision that cannot be corrected with glasses or contact lenses. Blindness can be partial and completely blind. Partial blindness is a situation where a person who has a very limited vision and best corrected visual acuity of worse from 6/18 to 3/60 [2]. While for complete blindness is a situation where a person who cannot see anything including the light and best corrected visual acuity of worse is less than 3/60 [3].

Generally, visually disabled people face difficulties to match the colour of everyday life. This comprises activity to find the colour of cloth, the colour of food and surrounding items near them. Before this, there are many methods develop to solve this problem like braille sticker with colour code embedded, help from other person and device that can produce audio output from colour sensor data. Basically, for the third method can be divided into two which are reflective sensing and transmissivity sensing.

The purpose of this study is to study the behaviour of colour recogniser to detect the desired colour. To achieve this, a prototype colour recogniser is developed and fabricated by using 3D printer machine. The colour recogniser consists of three components; microcontroller, a colour sensor and a pair of speaker. To ensure the device is working correctly in determining the type of colour detect, an experiment to validate the device was performed. The validation test is carried out using 12 standard colours which are red, orange, yellow, green yellow, green, green cyan, cyan, blue cyan, blue, blue magenta, magenta and red magenta. These colours are chosen because of the specification of the devices which utilised all this colour.

II. RELATED RESEARCH

As blind people have difficulty in perceiving the surrounding world, they rely solely on sound stimulus and touch stimulus. The sound is one of the most important senses that the blind or visually impaired users to locate objects in their surroundings and to perceive information. A form of echolocation is used, similarly to that of a bat [4]. Echolocation from a person's perspective is when the person uses sound waves generated from speech or other forms of noise such as cane tapping, which reflect off of objects and bounce back at the person giving them a rough idea of where the object is. Next, touch is also an essential aspect of how blind or visually impaired people perceive the world. Touch gives an immense amount of information in the person's immediate surroundings. By feeling anything with detail gives off information on shape, size, texture, temperature, and many other qualities. Touch also helps with communication; a braille is a form of communication in which people use their fingers to feel elevated bumps on a surface and can understand what is meant to be interpreted [5].

There are about three types of colour systems which are an additive colour system, subtractive colour system and CMYK colour system. For RGB model that is shown in Figure 1, the light primaries are red, green and blue. When combined, red and green light rays produce yellow, blue and green produce cyan, red and blue produce magenta. If red, green and blue mix it will create white (light). This colour model is used in computer monitors, television sets and theatre. This system applies only to devices employing light such as computer monitor. Next, there is a subtractive colour system which is red, yellow and blue as a basic primary colour. These primaries are the pure colours which cannot be created by mixing any other colours. The secondary colour is the result of mixing any of the two primaries colour. Tertiary colours result from mixing the secondary colour. In subtractive colour theory, all colours mix to form black colour. Lastly, there is CMYK colour system which means cyan, magenta, yellow

and black colour system. These four colours are used as primary colour. The CMYK colour system is used in the printing industry. When this primary colour is combined, the result is grey [6].

RYB model RGB model CMYK model

Figure 1: Colour System

Electromagnetic radiation is characterised by its wavelength, frequency and intensity. When the wavelength is within the visible spectrum (the range of wavelengths humans can perceive, approximately from 390 nm to 700 nm), it is known as "visible light" [7].

Table 1
Colour of Visible Light Spectrum

Colour	Wavelength Interval (mm)	Frequency Interval (THz)
Red	700-635	430-480
Orange	635-590	480-510
Yellow	590-560	510-540
Green	560-520	540-580
Cyan	520-490	580-610
Blue	490-450	610-670
Violet	450-400	670-750

III. Research Methodology

When designing this device, several stages of concept development and design process should be followed. The stage of concept development and design process will ensure the overall progress is organised and structured. Starting with concept generation, it will provide with the unique and original concept. Then, product design specification should be constructed to make the component selection process more manageable. Then, proceed with functional decomposition, and the morphological chart is constructed. Then, proceed with concept visualisation for design. For this concept visualisation process, three designs were managed to be produced. Then, evaluation concept process should be done to choose the design being selected. After finishing the design selection, we can proceed to design development. In design development process, it involves a combination of hardware and software of the design. For hardware part for this device, it consists of the design of the case and electronic component selection. The electronic component selection involved is Arduino Uno, TCS3200 colour sensor, catalex serial MP3 player and power source.

A. *Casing Design*

Design of casing is developed using Solidwork software which will be produced using a 3D printer. The casing is developed based on concept development and design process method. Figure 2 shows the finalised design of colour recogniser. The design of the device is very user-friendly, practical and cost-effective. The size of the device is also acceptable to hold by human hand.

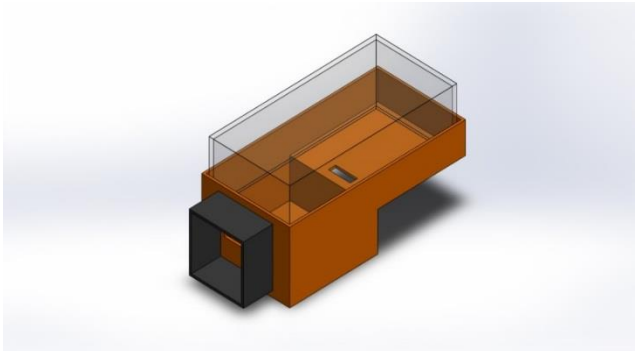

Figure 2: Finalized design

B. *Microcontroller*

Arduino/Genuino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which six can be used as PWM outputs), six analogue inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started.

C. *Colour Sensor*

The TCS3200 is a programmable colour light to frequency converter that combines configurable silicon photodiodes and a current-to-frequency converter on a single monolithic CMOS integrated circuit. The output is a square wave (50% duty cycle) with frequency directly proportional to light intensity (irradiance).

D. *Audio Module*

Catalex MP3 player module is a simple MP3 player device which is based on a high-quality MP3 audio chip (YX5300). It can support 8kHz to 48kHz sampling frequency MP3 and WAV file formats. There is an SD card socket on board to plug the micro SD card that stores audio files. The module has a microcontroller that can control the MP3 playback state by sending commands to the module via UART port, such as switch songs, change the volume and play mode and so on. It is compatible with many controllers like Arduino, AVR and PIC microcontroller.

E. *Schematic Diagram*

This combination of all components is powered up using one unit of the 9V dry cell which is placed at the bottom of the device. Figure 3 shows the schematic diagram of the colour recogniser device.

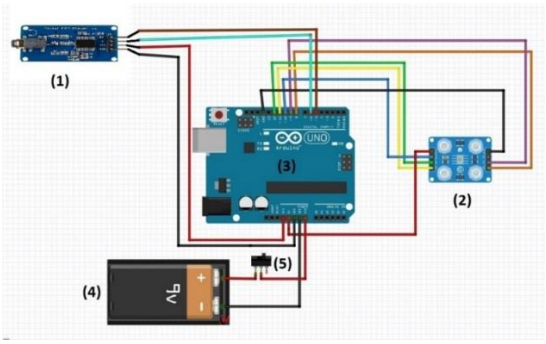

Figure 3: Schematic diagram; (1) Catalex serial MP3 player, (2) TCS3200 colour sensor, (3) Arduino UNO, (4) 9V dry cell, and (5) Toggle switch

IV. RESULT & DISCUSSIONS

The prototype of colour recogniser is shown in Figure 4. The prototype casing is fabricated by using a 3D printer. It is a simple casing where it has few compartments for placing the colour sensor and other components like Arduino board, speaker and battery.

Figure 4: Prototype of colour recogniser

Before the prototype is tested on the colour of the object, it needs to be validated. The validation of the device was performed to ensure that the device is working correctly to determine the type of colour correctly. Validation test is carried out using 12 standard colours which are red, orange, yellow, green yellow, green, green cyan, cyan, blue cyan, blue, blue magenta, magenta and red magenta as shown on a wheel colour in Figure 5 below. These colour are chosen because of the specification of the devices which utilise all this colour. During that test, the condition is in room condition with the moderate light source from environment up to 550 lux.

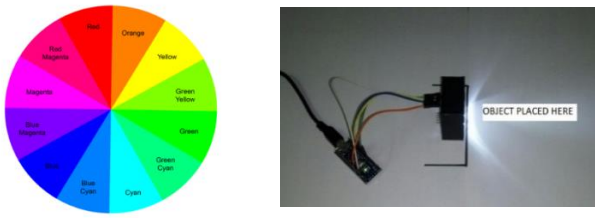

Figure 5: Validation layout

During the validation process, the object with standard colour is placed close to the colour sensor. The raw data output received from colour sensor through microcontroller is converted into a table to make a clear picture of a trend for colour recognition process. Figure 6 shows the result of the colour sensor in term of frequency for red, green, blue and yellow colour. It is observed that there is some difference between the reading of device sensor data and colour wheel data. According to the graph trend for red colour, the red component will be lower to green and blue component because the dominant colour which is red component will be filtered out. So, the concept is same with colour wheel data where the dominant colour will be higher compared to other components. This is the same with green colour and blue colour where their corresponding component which is a green component and the blue component will be lower.

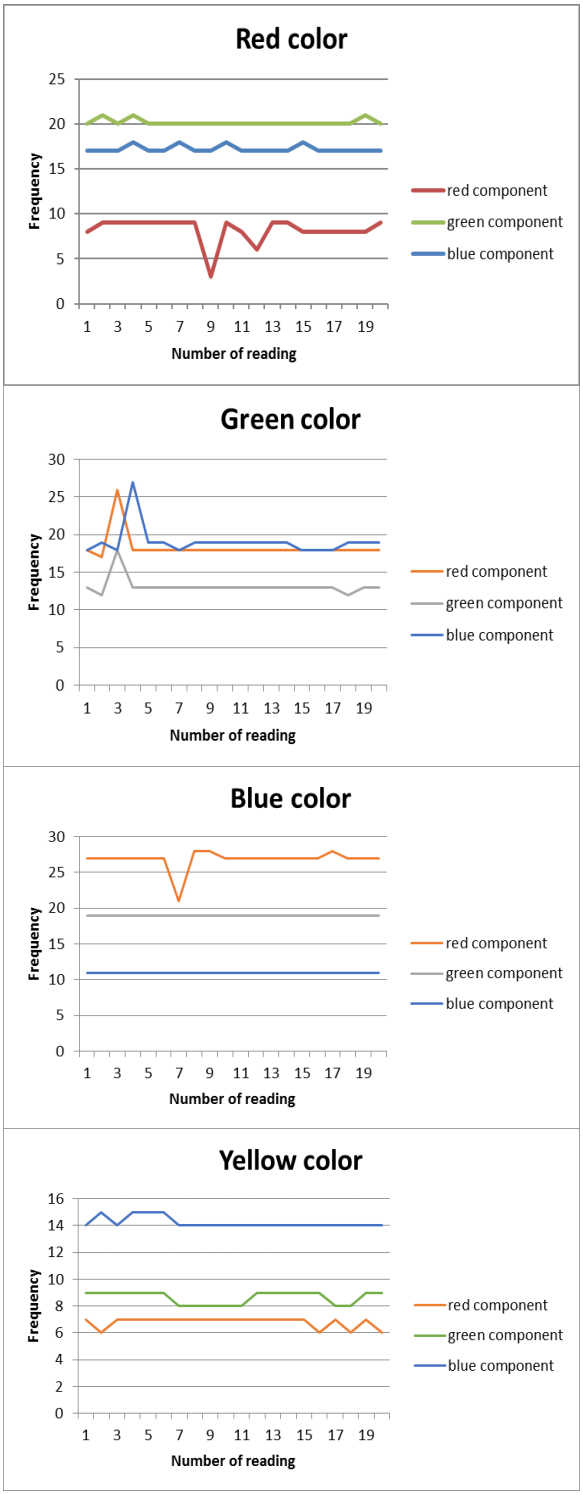

Figure 6: Graph of frequency for red, green, blue and yellow colour

Next, there is an additive colour which is orange, yellow, yellow-green, green-cyan, cyan, blue-cyan, blue-magenta, magenta and red-magenta. Additive colour is a combination of 2 primary colour consist of red, green and blue. For example, we focus on yellow colour. For yellow colour, according to the standard colour wheel, the dominant colour component will be a red component and the second place dominant will be green. So, it is comparable with graphs trends of yellow colour which shows the red component will be dominant and green component will be second place dominant.

V. CONCLUSION

This paper presented a preliminary study on colour recogniser for visually impaired people. The colour recogniser consists of three components; microcontroller, a colour sensor and a pair of speaker. To ensure the device is working correctly in determining the type of colour detected, an experiment to validate the device was performed with 12 standard colours. The result shows that validation of the colour recogniser has proved the ability of colour recogniser. The device is beneficial and useful to assist people with visual disability to determine the type of colour in their surrounding object. The design of the device is very user-friendly, practical and cost-effective for visually disable people and can help them to solve their everyday problem.

ACKNOWLEDGEMENT

The authors wish to thank Universiti Teknologi Malaysia (UTM) for providing the funding and facilities to conduct this research with Project No. 16H36.

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